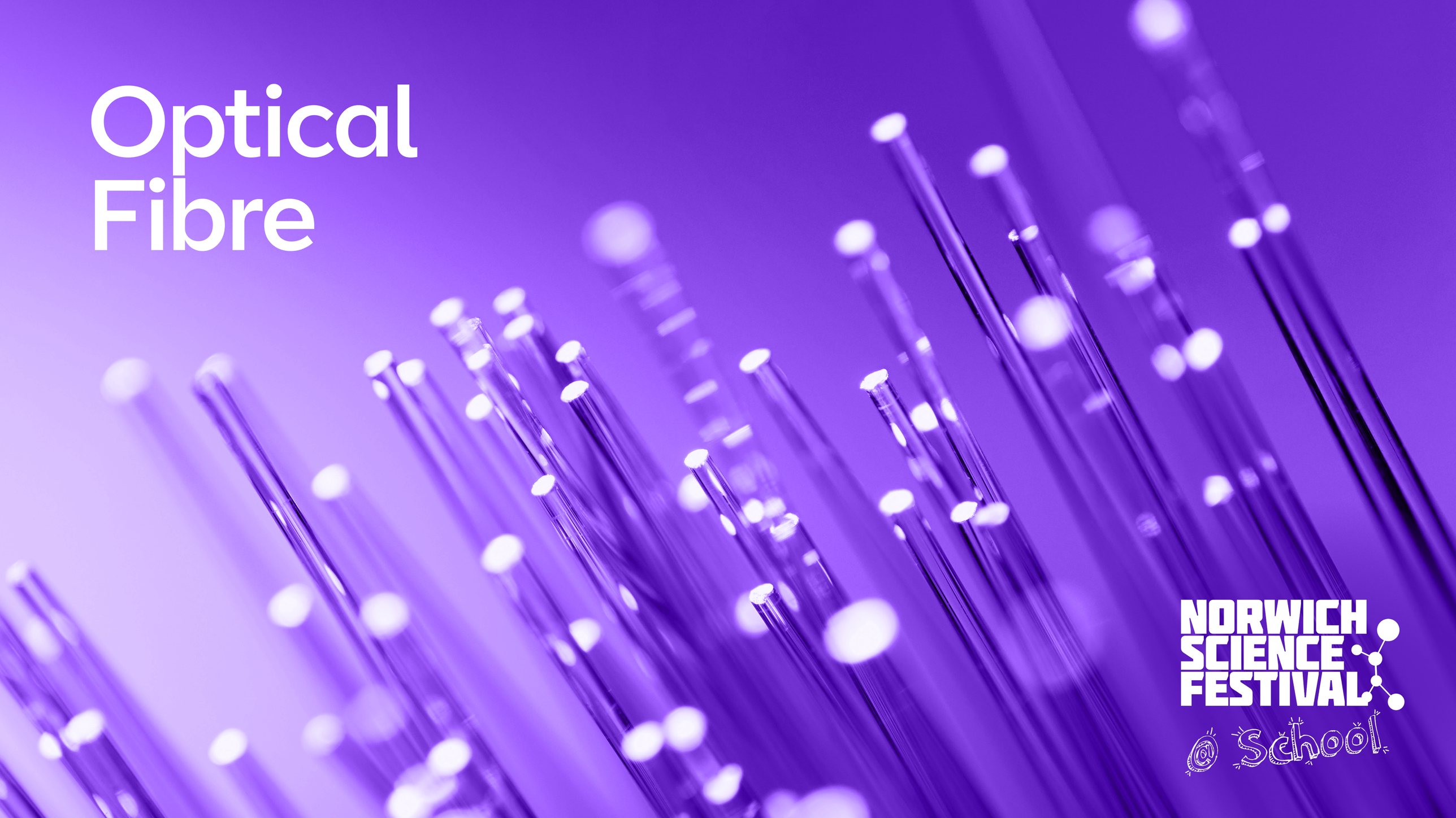
Optical Fibre



NORWICH SCIENCE FESTIVAL @ School

Optical Fibre

What is an Optical Fibre?

Optical fibres are made from really thin pieces of glass about the same size as a single strand of human hair. In fact, they are so thin that they can bend! One strand of fibre is made up of a tiny piece of glass protected by an outer layer called cladding, and you can have lots of these strands in a single fibre optic cable.

How do they work?

For hundreds of years Morse code has sent pulses of light in order to send a message (you can try this yourself later with a torch). Optical fibres use the same technique of sending pulses of light, but they transmit the light through glass which works a lot more effectively as the signal can travel for very long distances. The light goes in at one end and is reflected constantly along the glass until it emerges at the other end. This is known as total internal reflection. As the fibres are flexible, the pulses of light can be sent around corners which allows the signal to travel around obstacles without impacting their quality.

What are they used for?

When optical fibres are put into a fibre-optic cable you can send information, or data, through them as pulses of light. This means you can send information such as music, videos or games using lasers (light) and hair thin strands of glass (optical fibres) at high speeds over hundreds of miles.

With fibre, you can send enormous amounts of digital information much faster and much further than with traditional electrical cables. Fibre optic cables have to carry light over long distances without the original light source losing quality. If you think about when you shine a torch, you will notice that after a short distance the light eventually starts to fade away. Why isn't this the same for optical fibres? Have a go at the activities in this pack to shed some more light on this.

Find out more

- The critical angle and optical fibres: The plane mirror - https://atadastral.co.uk/go/nsfoff1
- Refraction of light: Optical fibres – https://atadastral.co.uk/go/nsfoff2

Teacher Links

- Do you see what I see? - https://atadastral.co.uk/go/nsfoft1
- Total internal reflection - https://atadastral.co.uk/go/nsfoft2
- Reflection and refraction - https://atadastral.co.uk/go/nsfoft3
- Amplitude, Intensity & Polarisation - https://atadastral.co.uk/go/nsfoft4

Unplugged activities

If you'd like to have a go at an unplugged version of this activity, here's one to get you started:

- Physics in a Glass: Reversing Arrows - this activity demonstrates a cool physics trick using the phenomenon of refraction- https://atadastral.co.uk/go/nsfofu1

Plugged-in activities

If you'd like to have a go at a plugged-in version of this activity, there's lots that you can try:

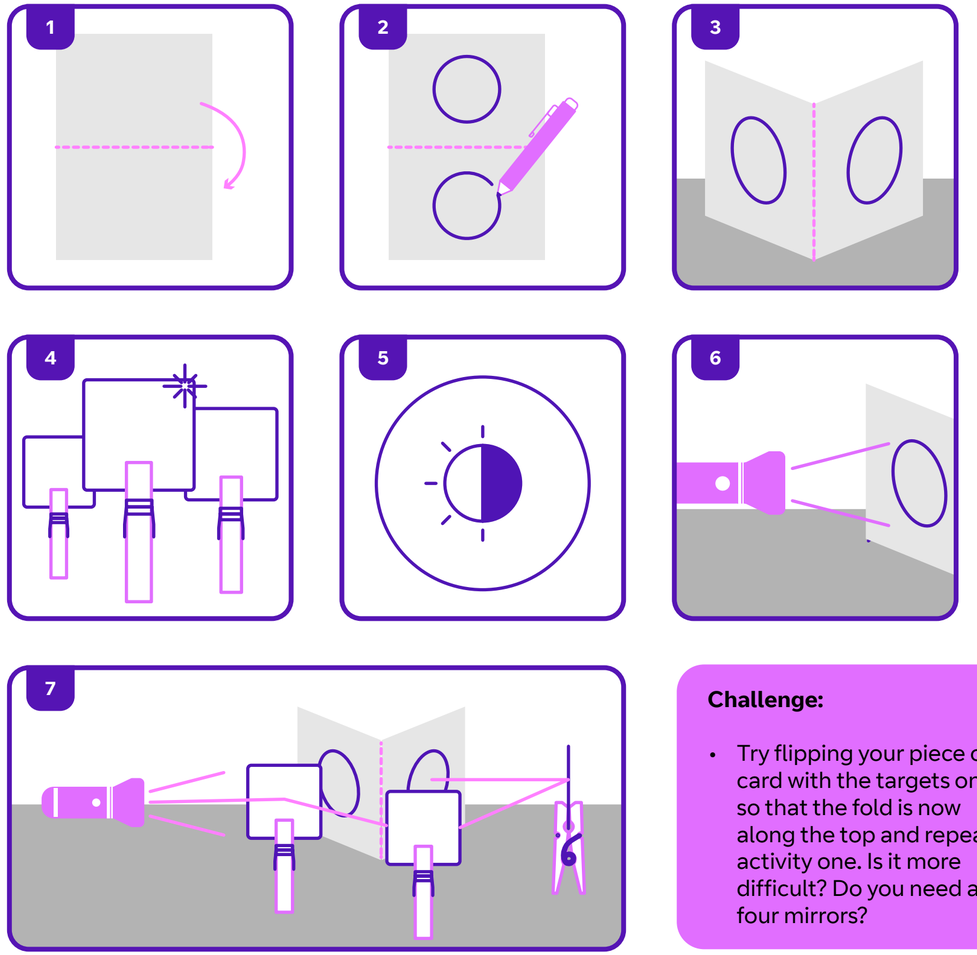
- The Light Pipe - a mathematical based activity looking at the physics of reflection and refraction based on a light pipe demonstration - https://atadastral.co.uk/go/nsfofp1
- Great Object Hunt: Light and Sound - look around and spot objects where science and technology have shaped our lives - https://atadastral.co.uk/go/nsfofp2

Activity One

Demonstrating how you can bend light using a light maze and reflection

1. First off, fold your piece of card in half.
2. Now draw a circular target on the card in the middle of each side of the fold.
3. Stand your piece of card on the table so it supports itself.
4. Next up, attach the pegs to your mirrors so you can stand the mirrors upright.
5. Ask the teacher to dim the lights in the classroom to make it easier to see the torchlight.
6. Set up the torch so it is shining on the circular target on one side of the card.
7. Now here comes the difficult part! Position your mirrors to reflect the torchlight so that the light is redirected around the piece of card and onto the circular target on the other side.

Now that we understand how light can be manipulated to bend around corners, we're going to look at how you can send data through that light source.



Challenge:

- Try flipping your piece of card with the targets on, so that the fold is now along the top and repeat activity one. Is it more difficult? Do you need all four mirrors?

Activity Two

Using light pulses to communicate data/ information

1. For this you'll need two teams (the teams can be an individual or groups of people).
2. One team will be the '**Torchlight Team**' – you will need a copy of the Morse code worksheet on page 4 and the torch (turned off).
3. The other team will be the '**Target Team'** – you need to stand opposite the **Torchlight Team**, about 2 metres away, with the target you made in Activity One. You will also need a copy of the Morse code worksheet on page 4.
4. The **Torchlight Team** should now pick their favourite animal.
5. Using the torch and Morse code, the **Torchlight Team** should attempt to spell out the name of the animal by shining the light onto the card target.
6. The **Target Team** should record the letters they believe they are receiving and then try to work out what the animal is.
7. The two teams should swap roles and try the activity again. Who can decode the longest animal name?

This is similar to how data is sent through an optical fibre… in this activity the torch was the transmitter, but in digital communications your Wi-Fi router sends light pulses down the optical fibre instead. When the data is received at the other end, it is decoded into binary 1s and 0s which the computer understands and can display on-screen – just like you 'decoded' the animal names.

In the extension task, we're going to look at this in a bit more detail and see how we can send data through light pulses in more difficult situations, where corners and obstacles are introduced.

This is similar to how data is sent through fibre optic cables over long distances, as the cables have to bend around obstacles like trees or buildings!

When they are bent, the light is still successfully passed through the optical fibre to its destination so you can watch Tik Tok on your phone, play games consoles online or stream music.

Extension: Sending data through Fibre Optics over long-distances

1. In your teams, stand opposite each other again, a few metres apart.
2. This time place an obstacle in the path of the torch light (for example a bag or a pencil case).
3. Using the mirrors from Activity One, both teams should work together to redirect the torchlight around the obstacle and back onto the target.
4. The **Torchlight Team** must use Morse code again to spell out the letters of a word of their choice with the torch.
5. Can the **Target Team** work out what the word is correctly despite the obstacle?
6. The two teams should swap roles and try this extension activity again. Who can do it in the fastest time?

Morse Code Worksheet

Guidance
Send one letter at a time.

- For ‘dots’ – turn the torchlight on for one second before turning it off again.
- For ‘dashes’ – turn the torchlight on for three seconds before turning it off again.
- Allow a five second gap between each letter to help your teammates work these out correctly.